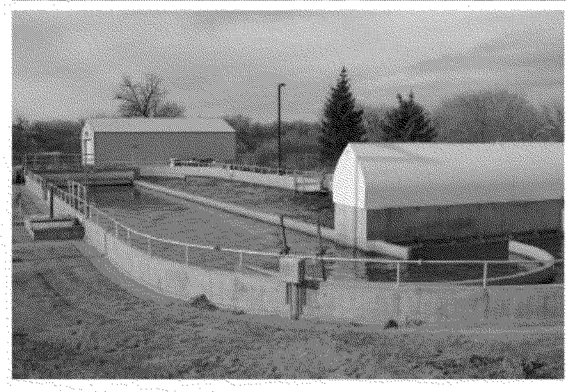
CHINOOK, MONTANA

OXIDATION DITCH/ACTIVATED SLUDGE—PROCESS CONTROL AND MECHANICAL MODIFICATIONS

SYSTEM SUMMARY

Official Name: Chinook Wastewater Treatment Plant (WWTP)

Location: 300 Daffy Hills Lane, Chinook, MT 59523 (latitude: 48° 34′ 46″N; longitude: 109° 12′ 52″ W)



Permitted design flow: 0.500 MGD

Service area: City of Chinook (2010 population of 1,203)

System type: Activated sludge/oxidation ditch

Initial year of operation: 1984

Upgrade type: Improved process controls and made mechanical modifications

Upgrade year of operation: Mixers added in 2004; oxidation-reduction potential (ORP)/supervisory control and data acquisition (SCADA) added in 2013

Permitted effluent nitrogen limit: 31.1 lb/d annual average TN (7.46 mg/l at 0.5 MGD)

Pre- and post-upgrade effluent nitrogen performance: 20.3 mg/l pre-mixer upgrade; 17.3 mg/l pre-luminescent dissolved oxygen (LDO)/ORP upgrade; 5.44 mg/l post-upgrades

Permitted effluent phosphorus limit: 5.7 lb/d annual average TP (1.37 mg/l at 0.5 MGD)

Pre- and post-upgrade phosphorus performance: 4.13 mg/l pre-mixer upgrade; 2.48 mg/l before pre-LDO/ORP upgrade; 1.72 mg/l post-upgrades

Average Monthly Concentration	Pre-Mixer Upgrade	Post-Mixer Upgrade	Post-ORP/LDO Control Upgrade	Units
Effluent Total Nitrogen	20.3	17.3	5.44	mg/l
Effluent Total Phosphorus	4.13	2.48	1.72	mg/l

DECISION PROCESS

In 2004, mixers were added in the oxidation ditch to save on energy costs. In 2012, nitrogen removal was required for permit reissuance. Shortly thereafter, staff received nutrient removal training and applied their newfound knowledge to demonstrating how process changes can significantly reduce nitrogen. The upgrades described were the most economical way to consistently meet new permit requirements. A motivated, educated, empowered staff—using upgraded monitoring equipment—achieved effective, consistent nitrogen removal in a 1984-vintage oxidation ditch treatment plant that was modified in 2004 for energy efficiency, but never designed for nutrient removal.

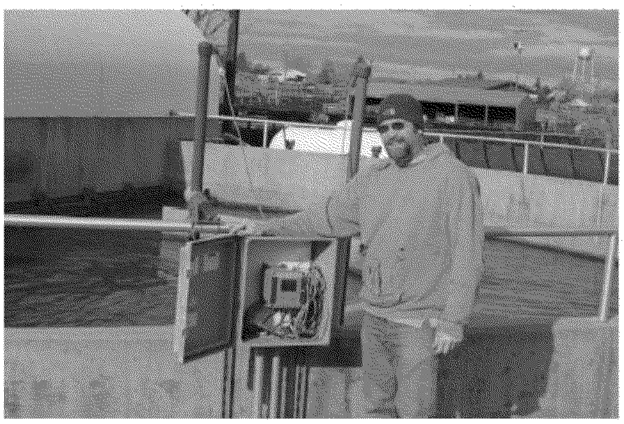
SYSTEM OPTIMIZATION DESCRIPTION

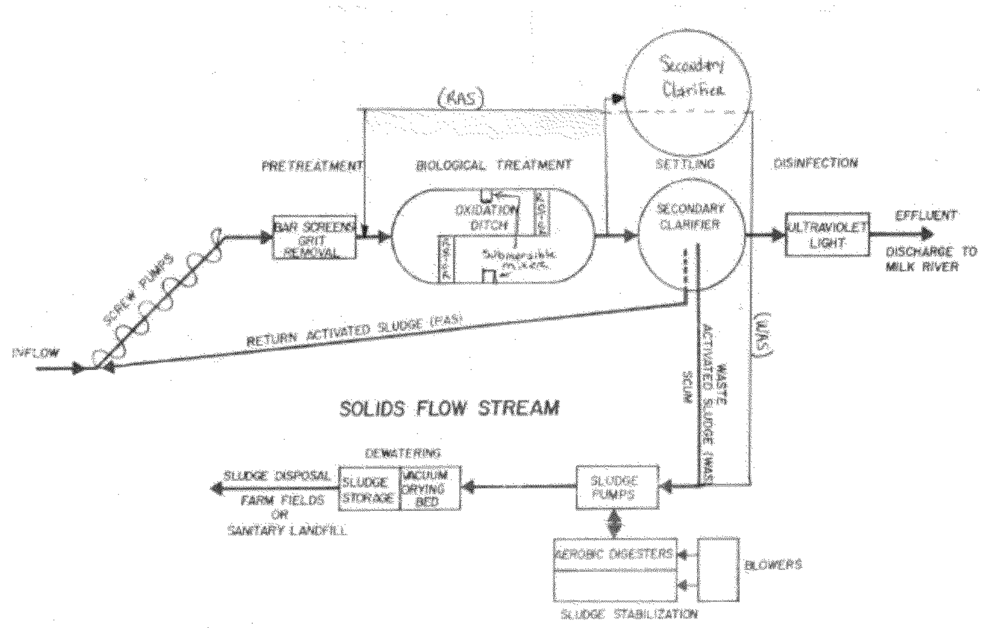
Improvements came about as a result of process changes. A series of minor physical upgrades provided tools that were used to support the process changes, but were not the cause of the improvements. The biggest capital expense was for energy savings equipment that later proved to provide a dual benefit: nutrient removal and energy savings. Process optimization proceeded in four steps.

1. In 1984, a single oxidation ditch equipped with dual aeration rotors was constructed to provide TSS and BOD removal. The original installation was designed for ammonia removal, not for TN or TP removal.
2. In 2004, minor changes were made to improve energy efficiency. As originally constructed, both of the oxidation ditch rotors ran continuously. As a result, the original equipment provided a surplus of dissolved oxygen (DO). To allow for the cycling of the fixed-speed aeration equipment, rail-mounted mixers were installed so the flow would continue to stay suspended and circle the oxidation ditch with the rotors turned off. A DO probe was installed and integrated with the SCADA system to maintain a DO setpoint of 4–5 mg/L by cycling the rotors on and off. At the lower DO concentration resulting from the energy savings changes, incidental improvements in nitrogen and phosphorus removal occurred.

3. In 2012, Chinook staff attended a 2-day training class sponsored by the Montana Department of Environmental Quality (DEQ). Using the knowledge they gained, staff experimented with extended air-off cycle times. By allowing the DO in the ditch to cycle between anoxic and oxic conditions, an immediate 50 percent improvement was observed in nitrogen removal. No equipment was purchased; no funds were expended. In fact, because of reduced rotor operating time, electrical costs were reduced. For zero capital investment and at reduced operating expense, Chinook staff reduced TN by 50 percent. And, as a result of the lower tank DO concentrations, some incidental improvements in TP removal also occurred.

4. In 2013, an ORP probe was installed to provide improved process control. At the same time, the old DO probe (2004 vintage) was replaced with a new LDO probe. Both probes were integrated with the plant's SCADA system. Using the new instrumentation, plant staff have been able to maintain optimal conditions for biological nitrogen removal and incidentally provide some level of enhanced biological phosphorus removal, while enjoying additional energy savings.





COSTS AND OTHER IMPACTS

Capital costs: Approximately $5,000 for ORP probe and integration with SCADA.

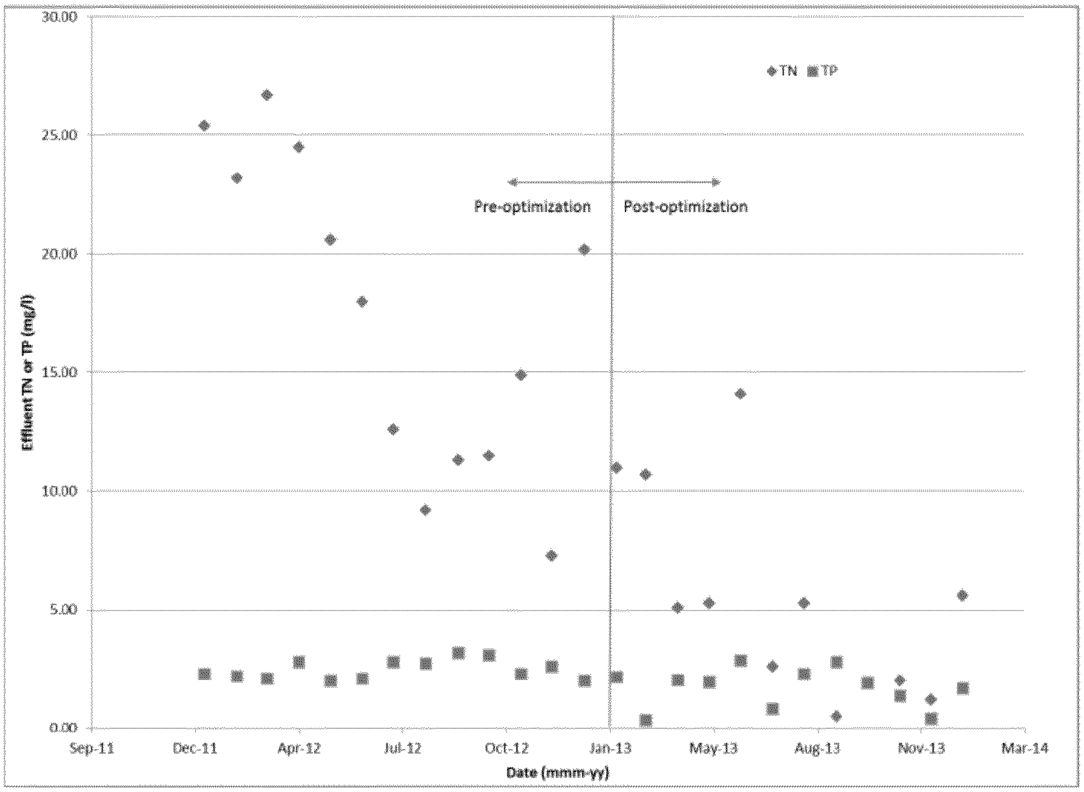
The energy savings improvements implemented in 2004 (i.e., mixers, DO probe, SCADA) cost $68,200. In 2013, the DO probe was replaced with LDO equipment for $8,000.

Operational costs: Less than $1,000/year (oil and grease for mixers and 1–2 hours/year to change the oil). Cost savings have been realized. The reduced electrical consumption more than offsets the expense of cleaning, calibrating, and maintaining the ORP probe.

Technical assistance received or needed: In 2012, Chinook staff attended a 2-day training class sponsored by the Montana DEQ. Using the knowledge they gained, staff felt empowered to experiment with extended air-off cycle times and other process modifications.

PERFORMANCE

Pre- and post-upgrade TN and TP statistics are summarized in the chart below.



FUTURE IMPROVEMENTS

No improvements are planned at this time. Nitrogen removal is still a relatively new requirement, so the plant is currently working on refining the process.

CONTACT INFORMATION

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OTHER RESOURCES

City of Chinook: http://www.cityofchinook.com/index.html

State of Montana MPDES Permits: http://deq.mt.gov/wqinfo/mpdes/majorpermits.mcpx